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COMPLETE SPECIFICATION

Improvements in and relating to a Process and Plants to Produce and Harvest Ice, and Ice Blocks obtained thereby

I, EUGEN WILBUSHEWICH, a Citizen of Israel, of Nazareth Street, Haifa, Israel, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method for producing ice blocks in upright ice moulds. Generally such ice moulds are first subjected to a freezing process and formed ice blocks are then detached from the walls of the moulds and the freezing elements to enable them to be harvested, and a new mould-filling and freezing process to be commenced.

In my prior Patent No. 691,197 there is described and claimed a method of producing ice blocks in and harvesting from an upright mould having a bottom adapted to swing about an horizontal axis, consisting in holding the said bottom lightly closed against the mould and commencing the freezing action prior to or simultaneously with filling the mould, to cause the said bottom to adhere to the mould by the freezing of residual liquid or liquid introduced into the mould, and subsequent to the formation of an ice block, commencing a thawing action to cause the block to become detached from the mould and to displace the said bottom.

According to the invention a process for the production of an ice block consists in circulating a liquefied refrigerant through a tubular evaporator contained within the mould and using part of the vaporised moisture laden refrigerant from the said evaporator to supply a jacket also acting as an evaporator and surrounding the mould.

According to a further feature of the invention the moisture in the vaporised refrigerant is allowed to settle along the return path of the refrigerant gas and to flow into the jacket.

Further according to the invention apparatus for carrying out the above process comprises an upright ice mould with a displaceable bottom adapted to be held against the mould, a tubular evaporator extending into and substantially the full length of the mould, a jacket also acting as an evaporator and surrounding at least the lower part of the mould and connected with the tubular evaporator therein, means for circulating a refrigerant through the said evaporator and for subsequently allowing some of the refrigerant to flow from the evaporator into the jacket to gasify and dry through evaporation therein so that water introduced into the mould is frozen into an ice block, and means for replacing the refrigerant medium with a warm medium for causing the ice block to become detached from the said evaporator and to enable it to be harvested.

The invention also provides a process and apparatus for filling the ice moulds.

In the production of ice blocks it has been found that the following occurs:—

(a) In square ice-moulds, of standard 18cm. size, one tubular internal freezing element of 15mm. outer diameter, will freeze up an ice area about 3½ times larger than that frozen by employing only a jacket surrounding the ice mould, considering unit areas of the walls of the evaporators in both cases.

Outer evaporators, therefore, contribute only in a small way towards the ice formation, especially in cases when, for standard ice block dimensions, several, say five, internal tubular evaporators are used.

(b) Ice freezes with an increase in volume in that direction where least obstructions are present. Ice blocks freezing up evenly over the whole length of long-conical moulds will show an elongation towards the wider mould bottom only shortly before the end of the freezing process the pressure due to the elongation becomes rather strong and is substantially evenly distributed over the cross-sectional area.

[*Price* 2/8]

(c) Ice films between metal surfaces have high breaking strength and are fluid-tight.

(d) Ice blocks produced by means of refrigerant evaporators acting directly on ice moulds both from the outside and internally, or only internally by using several evaporators, show increased stability compared with standard ice blocks and have an ice of a character which shows high resistance to melting.

(e) Clear ice blocks are effectively obtained, if simultaneously with the admission of water into the ice moulds, through their bottom, the water is degassed by blowing in air, also through the bottom.

(f) A plurality of tubular evaporators within the ice moulds, make it possible to freeze ice blocks from seawater, or from other solutions or juices, with a substantially equal salt concentration, or the like, across the ice block.

When reference is made herein to a refrigerant this is intended to mean a liquefied gaseous medium which can be circulated in known manner and can evaporate through heat exchange in said internal tubular and external jacket evaporators the apparatus including a liquid separator, compressor with oil separator, condenser, etc. The liquid separation in known manner serves to improve the efficiency of the refrigerant plant the compressor of which is then supplied with dry gas.

The invention renders it possible to obtain within short freezing periods, better ice blocks than has hitherto been the case. The plant according to the invention is simple in construction mainly due to the small liquid separator now required and is highly efficient for continuous automatic ice block production.

In order that the invention may be more readily understood reference will be made to the accompanying drawings which illustrate by way of example preferred embodiments thereof.

Fig. 1 shows a sectional view along an ice mould, in connection with arrangements for the automatic ice block production and harvesting;

Figs. 2 and 3 are fragmentary elevations, of the lower part of the ice mould;

Fig. 4 illustrates details of the hinge construction for the movable mould bottom;

Fig. 5 shows an embodiment for an ice block receiving trolley, with deflector curve for the ice blocks when harvested;

Fig. 6 shows the trolley of Fig. 5 in cooperation with several mould batteries;

Figs. 7 and 8 are diagrammatical views of a mould battery, an horizontal sectional and a perspective view, respective to illustrate a freezing and detaching process;

Figs. 9, 10 and 11 are cross-sectional views of ice blocks;

Figs. 12 and 12*a* show perspectively groups of ice moulds arranged in batteries, and a variant in conjunction with a circulating refrigerant, compressor, and condenser, and served by a harvesting trolley.

Referring first to Figs. 1-3, 1 denotes an upright ice mould, preferably of square cross-section and slightly diverging towards the bottom. The ice mould is surrounded, near its bottom end, by a jacket chamber 3 which serves as an outer evaporator chamber and the lower wall of which is the bottom flange 6 of the mould. To the bottom edge of the mould is fitted a bearing housing 11 for a movable bottom plate 7. The plate 7, by means of a spindle 8, is pivoted in a bush 10 and apart from the shown upper position it can, as drawn in dot-dash fashion, also adopt a tilted position 7*b* as well as a lower position 7*a*. A lowering is made possible through the bush 10 which can vertically move in the oblong bearing housing into the lower position 10*a* (Fig. 4). The upper position of the bottom plate 7 is attained through springs 9 and 12, the forces of which control the tilting back and lifting of the plate so that, with the mould empty, the plate will bear lightly and not be necessarily fluid tight, against the flange 6.

A tubular refrigerant evaporator 24 ranges from the top into the ice mould 1. It is slightly tapered towards its lower end and is arranged coaxially to the mould, ending somewhat near the bottom plate 7. This internal evaporator, as tube 24 may be called, connects to the jacket evaporator 3 by means of a connecting pipe 68. This pipe 68 branches off the pipe 26 which leads to the suction side of a compressor of the refrigeration plant, not shown, via a solenoid regulating and stop valve 27, 27*a*. The plug of valve 27*a* is kept open when the solenoid is de-energised.

Concentrically to, and almost along the whole length of the internal evaporator 24, which is closed at its bottom end, is arranged a tube 25 which is open at its bottom end and which, on top, leads to a pipe 25*a*.

Via this pipe 25*a*, on the one hand from the right and a regulating valve 28 with check valve 28*a*, liquefied refrigerant can enter during a freezing process.

The pipe 25*a*, on the left, includes a solenoid valve 38, and on the other hand from the left, warm refrigerant media can enter the pipe 25, during a detaching process: the plug of valve 38 is normally, with the solenoid de-energised, held closed through spring pressure.

The jacket 3 connects, at 30, to a pipe 31 leading to a (not shown) refrigerant receptacle.

When several ice moulds are combined into a mould battery, the jacket 3 can be made common to all the moulds, when also the connecting pipe 68 and drain pipe 31 are common. The above mentioned valves, too,

are common for a mould battery.

The ice mould, or moulds of a battery, are filled with liquid 41, from an admission pipe 16. The distribution of liquid to the various moulds is done through a manifold tube 15 and flexible hoses, connected to nozzles 13 in the bottom plates 7. Another nozzle 14, in each bottom plate, is used to let in air, when clear ice is to be produced.

The admission pipe 16 has on top a float valve 17, which is placed level with the liquid level of the moulds so as to close the valve when this level is reached. Liquid, for instance, water, is supplied via valve 19 which is connected through pipe 18 with the float valve 17. This valve 19 can be opened electromagnetically, the energisation overcoming the closure spring 23 of the valve plug.

The ice mould, or ice mould battery, is mounted on a stand and at a certain distance from the floor, so that an ice block emerging under gravity force, as shown in dot-dash fashion, can readily be harvested.

In contact with the mould wall, is a thermostat 21. This thermostat closes an electric contact when the freezing temperature for the mould is reached. The float valve 17 in its lower position also closes a contact 22. The emergence of the ice block from the mould, drawn in dotted lines, before it is harvested, closes another contact, not shown, to electrically connect the lines 39 and 40.

The solenoids of the valves 19, 38 and 27*a* lie in electric circuits to be described below, supplied by a current source 4.

The regulating valve 28 works in conjunction with a thermostatic member or bulb 29, which is in contact with the pipe 26 leading to the suction side of the compressor. This arrangement regulates the flow of liquefied refrigerant, during the freezing process, to the evaporators, entering from the right of the pipe 25*a*.

The valves 38 and 27*a* are simply shown paralleled by lines 39*a*, 40*b*. Their solenoids will therefore work, when the lines 39, 40 are electrically connected through the (not shown) contact, in a way that the valve 38 is actuated to open whilst simultaneously valve 27*a* is actuated to close. In actual practice of course, when solenoid valve types are used that only open upon energisation, an intermediate relay can provide for the opposing valve actuation, as was described. This relay can be of the slow type.

In Figs. 1 and 2, a zone 41*a* at the bottom end of the ice block 41 is indicated. This zone represents unfrozen liquid which remains till shortly before the completion of the ice block formation, as will be described below. The final freezing up also of this zone 41*a*, results in an elongation of the ice block 41 towards the bottom, and is indicated in Figs. 1 and 2 in dot-dash fashion, the plate 7 is then shifted parallel. The pressure due to this elongation is large and tears open an ice film between mould bottom 7 and mould flange 6 which was formed right at the beginning of the freezing process.

Instead of the lowering into the shifted position 7*a* through employing a sliding bush 10 in the bearing housing 11, a relatively thin, springy bottom plate can be used, which is elastically dished under the influence of the pressure exerted by the elongation of the ice, so that in this case a plain hinge, or bearing, can be used and the springs 12 omitted.

Figs. 7 and 8 give diagrammatical cross-sectional and fragmentary perspective views of a mould battery, comprising several moulds. In Fig. 7, 62 denotes a heat insulating layer which is applied to walls 61 for the mould battery surrounding the ice moulds 63 at a certain distance. 64 denotes the internal evaporators and these via pipes 68, connect to the jacket evaporator 65 which is common to all and surrounds the lower part of each mould. The walls of the moulds 63 are enveloped by a fluid, for instance, air, which is made to flow across the mould battery by means of a ventilator 66. The fluid, entering at 67 in the direction of the arrows, will envelop the walls of the individual ice moulds, and will expedite the detaching of the block by means of warm fluid, or by means of cold fluid.

The pipes 68 are preferably so placed that they act as deflectors for the passing fluid to equally envelop all mould walls. Additional means, for instance, electrically heated bodies 70, can be provided in order to accelerate the detaching process. Also, other bodies, not shown, and as effective, can be used in the heating up of the detaching fluid, e.g., the warmed up bodies of either the compressor, oil separator, condenser, or the like, which all work in conjunction with the refrigeration plant.

Instead of arranging the pipes 68 away from adjacent moulds 63, these can be placed in permanent, heat-conductive contact with the mould walls. In general, the said pipes 68 act as connections between the internal evaporators 64 and jacket 65 and their respective heat or cold is taken up by the passing enveloping fluid, so as to assist either the defrosting or freezing process in the ice moulds.

Fig. 8 also shows an ice block in the instant of emergence, after the detaching process. It is now due to drop down, and plate 7 will then flap back into the upper rest position.

A dropping ice block, or the ice blocks 41 falling away from a mould battery, as is illustrated in Figs. 5 and 6, are collected by a table trolley and can be rolled into a storage room. The table top of the trolley of Figs. 5 and 6 is curved in order to divert, and even-

tually collect horizontally, the vertically dropping ice blocks. The table 45 of the trolley 42 has for this purpose, after an initial vertical guide section 47, a parabolic shape 48, continuing and ending at 49, horizontally.

The table top is provided with a stop 50 at the horizontal end, and at the side, has guide walls 46. Wheels 43, on rails 44, allow ready rolling. The trolley 42 has a locating lever 60*a* which co-operates with grooves 60 in the battery stand (Fig. 6), so that as shown in Fig. 5, the trolley will receive and divert horizontally, the ice blocks 41 when they drop from a mould battery. If in a plant for the production of ice blocks, a row of mould batteries is provided, as is diagrammatically shown in Fig. 6, one trolley 42 can serve all the batteries and accordingly, a corresponding number of grooves 60 is provided in the battery stand to secure an aligned location of the trolley 42 beneath each mould battery.

In Fig. 12, a plant for the production of ice blocks is illustrated, the plant having several mould batteries mounted on a stand 69 at a distance from the floor. Here as well, a common trolley 71 for all mould batteries is provided, which can be moved underneath the row of mould batteries. However, instead of a curved top this trolley comprises a flat table, and has feet 69*a* which act as guides when the table is lifted and lowered. Whilst moving vertically, the feet 69*a* of the table collaborate with the battery stand 69 in a manner to enable proper alignment and positioning to be achieved during the harvesting process. Only in the lowered position of the table, due to the flattened parts 69*b* of the stand 69, will it become possible to roll the trolley horizontally along the rails.

Fig. 12 shows, with the same reference characters as in Fig. 1, a number of mould batteries together with the refrigeration plant, the water supply and air supply. Accordingly, a compressor 35 is indicated and a condenser 34 into which compressed refrigerant flows. The condenser is provided with a receptacle 33 for liquefied refrigerant, and to this receptacle is connected on the one hand pipe 25*a*, and on the other hand a pipe 72. As was described above, pipe 25*a* serves, during the freezing process, to supply cold refrigerant to the internal evaporators of the individual ice moulds, via a regulating valve 28 which is common to a mould battery. The delivery side of the compressor leads also to the valves 38, common to each mould battery and which, as was described above, can be operated electro-magnetically to admit, during a detaching process, warm refrigerant medium into the internal evaporators.

The suction side of the compressor 35 evacuates the individual mould batteries, during the freezing process, and removes refrigerant via valve 27, pipe 26, and the liquid separator 26*a* which is common to the entire plant.

During the detaching process of one or the other battery, liquefied refrigerant medium, drained off by the pipes 31 is carried to the liquid receptacle 33 of the condenser, via the solenoid valves 72*a*, 72*b* or 72*c* which are common to each mould battery, and the collector tube 72. The said valves can, during the detaching process of the corresponding mould battery, be opened electro-magnetically, in known manner.

In larger plants, instead of employing the receptacle 33, a separate liquid collector vessel 32 can be provided, as shown in Fig. 12*a*, which becomes operative during a detaching process. If liquefied refrigerant enters, any unduly high pressure within the vessel 32 is relieved by a pipe 36 and the adjustable check valve 37, towards the suction side of the compressor 35. A valve 73 allows, also with the arrangement of Fig. 12*a*, that the collector tube 72 can connect to the liquid receptacle 33.

74 denotes an air compression device which is common to the whole plant, for the supply of air to be blown into the ice moulds, via supply line 75 and the nozzles 14.

Fig. 9 shows a section across an ice mould Z, which apart from an evaporator jacket A is provided with five internal evaporator tubes F. The said evaporators F, with their refrigerant entry pipe G, are, as is illustrated, disposed symmetrically within the square space of the mould.

Other cross-sectional views for ice moulds are shown in Fig. 10 and 11, and in Fig. 10 a rectangular ice-block, whilst in Fig. 11 a substantially triangular ice-block is formed, without the effect of the direct acting outer jacket being shown.

Ice, in known manner, develops stepwise through ice layers E formed around the internal freezing elements and these layers increase in circumference toward the walls (Fig. 9). The ice zones from various internal freezing elements, when they meet each other, and those layers E developed through the jacket, create contacting surfaces S, shown dotted in the figures. The lines S, in all the illustrated arrangements, do not run parallel to the edges of the obtained ice-block.

The ice production plant operates in the following manner:—

(a) *Filling Process.*

It is presumed that the ice mould 1 had just been emptied, after harvesting of an ice block 41, when the bottom plate 7 was tilted into the position 7*b*. This harvesting process results in a filling process.

The bottom will flap back into the upper position, governed by the springs 9 and 12, and rests lightly and in no way water-tight, against the flange 6 of the lower part of the mould. In this upper position, the electrical

contact between lines 39 and 40 which was made during the previous detaching process, remains open and this results in a switch-over to the freezing process, as will be described below.

Immediately at the start of the freezing process, when cold refrigerant also enters the jacket-evaporator chamber 3, the flange 6 is cooled down to such a degree that the water which is present on the bottom plate 7 is frozen and thus the mould rendered water-tight.

Liquid which was retained during the previous freezing process, in the common admission pipe 16, and the manifold tube 15, can now flow out and, in entering the mould, will wet the mould bottom which, as was described, becomes water-tight through freezing on to the flange 6.

As the admission pipe empties itself, the float valve 17 opens, and the contact 22 which is actuated by said valve is closed, to prepare, at one point, the circuit for the solenoid of the supply valve 19. This circuit is completed when another contact, at the thermostat 21, is closed extending then, from the current supply source 4, via the contacts 21 and 22, to the solenoid, and back via line 20*a*. The thus energised solenoid valve 19 keeps the water supply on until, upon the pre-set liquid level for the moulds being reached, and through contact 22 then being opened again, it is automatically shut off again. This admission control guarantees an automatic filling of all moulds of a battery to the same level.

The admission of liquid to the ice moulds 1, through the nozzle 13 of the bottom plate 7, is at a controlled rate. Simultaneous with the admission of water to the mould, through its bottom, and also after the termination of the filling process, air which is supplied from a common air compression device 74 (Fig. 12) can be blown in, through the nozzle 14 in the mould bottom. This arrangement is rather effective in degassing the water for the purpose of eventually obtaining a clear ice block.

(b) *Freezing Process.*

The freezing process which had been started together with the filling process, will continue until the completion of an ice block 41. The ice development is mainly due to the internal evaporator 24, into which with valves 28, 28*a* open, liquefied refrigerant, for instance ammoniac, is introduced via pipe 25*a*.

This refrigerant medium is led, through the entry pipe 25, till near the bottom of the evaporator tube 24, and from there, it flows via the suction pipe 26, the valves 27, 27*a*, to the suction side (right) of the ammoniac compressor.

The liquefied refrigerant medium evaporates in the tube 24, through heat exchange with the liquid in the mould; the vaporised moisture laden refrigerant, from the tube 24 flows along past the connecting pipe 68 allowing some of the refrigerant to settle and flow into the jacket 3.

The ice formation is particularly effective through increasing ice zones developing round the internal evaporator 24. Finally, the ice will fill up almost the entire space of the ice mould, under expansion, or elongation, in the process of freezing up. The elongation, however so far, is not directed downward. At the lower end of the ice block, only right at the end of the freezing up of the block, can zone 41*a* freeze. This zone will during the freezing process, freeze up last due to the internal evaporator 24 not reaching far enough to the mould bottom 7 and because the jacket 3 has not yet developed ice to reach the centre. In the very final stage of the freezing process this zone 41*a* too will freeze up, causing an elongation towards the bottom. After tearing away the bottom 7 from the flange 6 to which it had been frozen, the said elongation will initiate the detaching process.

(c) *Detaching Process.*

The downward elongation, or stretching, of the ice causes an electrical contact between lines 39 and 40, and a current to flow from the current supply 4 to the solenoid valves 27*a* and 38, paralleled by means of the lines 39*a*, 40*b*, actuating them so that valve 27*a* is shut whilst valve 38 is opened.

Instead of the cold, liquefied refrigerant medium which flowed over pipe 25*a* into the entry pipe 25, warm refrigerant will now flow, from the left, through the now open valve 38 into the same entry pipe 25 of the internal evaporator 24.

This warm refrigerant medium runs inside along the internal evaporator tube 24 heating up its walls, and to the outer jacket which receives the warm refrigerant via the connection pipe 68. Any refrigerant which has collected in the jacket will be drained through pipe 31 and a valve (e.g., 72*a*, Fig. 12) which is open during the detaching process into a collector vessel. In Fig. 12, this vessel 33 is the one built with the condenser 34; in Fig. 12*a*, it is a separate collector vessel 32.

Simultaneously with the changing over of the valves, to heat up the walls of the evaporators, other means are put into operation, as indicated in Figs. 7 and 8, in order to warm up the walls of the ice moulds 63, from the outside. Thus, in accordance with Fig. 7, a ventilator 66 can cause a warm air current 67 to envelop and finally defrost, all ice mould walls.

Consequent upon the detaching of the ice block 41 from the evaporator walls, and the thawing free from the mould, the ice block will slide under gravity.

(d) *Harvesting Process.*

Fig. 12 illustrates the harvesting of ice blocks from the first mould battery, by means of a trolley table 71. Its table top has been lifted and raised to an extent that the ice blocks sliding away can readily deposit themselves thereon. It is then lowered, guided in the vertical guides 69*a*, and the group of ice blocks can finally be rolled away on the rails.

The long holes which remain within the ice block, due to the internal evaporation tubes, can be filled up directly after the taking off of the blocks. The ice blocks, having been produced at temperatures well under zero, keep cool to such a degree that in all cases the small amounts of liquid additionally to be frozen in said holes, can freeze up without requiring a separate freezing process.

In certain cases, it can be of advantage to utilise the tubes of the internal evaporators, which as described above will directly upon the emergence of the ice blocks become cooled again in a renewed freezing process, as pre-cooled guide rods to lead the refill liquid into the long holes disposed directly underneath in the ice blocks on the table on which they are resting during and after the harvesting action.

The ice production plant has been described as operating substantially automatically. It is of course, possible to extend the automatic operation or else, to employ manual operation, or different kinds of electrical control.

The ice block production is, in larger plants, done in a way that at any one period only one mould battery is in its detaching or harvesting process. This battery will then assist in converting into liquid form the used refrigerant medium, i.e., it will act as an auxiliary condenser for the plant and for the remaining mould batteries still in the freezing process, resulting in the advantage that also in such larger plants, a condenser of relatively small dimension can be employed.

What I claim is:—

1. A process for the production of an ice block in an upright ice mould consisting in circulating a liquefied refrigerant through a tubular evaporator contained within the mould and using part of the vaporised moisture laden refrigerant from the said evaporator to supply a jacket also acting as an evaporator and surrounding the mould.

2. A process according to Claim 1 wherein the moisture in the vaporised refrigerant is allowed to settle along the return path of the refrigerant gas and to flow into the jacket.

3. A process according to Claim 1 or 2 including the additional step of detaching the ice block from the tubular evaporator and the walls of the mould by circulating warm refrigerant through the tubular evaporator and subsequently supplying the warm refrigerant to the jacket to displace the liquefied refrigerant collected therein.

4. A process according to Claim 3 wherein the tubular evaporator extends downwardly into the mould and the jacket is arranged to surround only the lower part of the mould, and during the detaching of the block by means of the warm refrigerant, another warm medium is circulated over the exposed sections of the mould.

5. A process according to any of the preceding claims wherein the upright ice mould is provided with a displaceable bottom adapted to be held against the mould during the filling and freezing action, by an intervening ice film, and the operation of the process is such that the last zone of water in the mould to be frozen, is above the centre of the bottom, so that during completion of the freezing action the elongation forces generated in the block serve mechanically, to detach the bottom preparatory to the detaching and harvesting action of the ice block.

6. A process according to Claim 5 wherein the downwardly directed ice elongation towards the end of the freezing action on completion of the ice block, is utilised to initiate automatically the detaching action, and the harvesting action at the end of the detaching action is utilised to initiate automatically the filling and freezing action.

7. A process according to Claim 5 or 6 wherein the mould is filled in two steps, first that in which the displaceable bottom is wetted after the emergence of the ice block, so as to render the gap between the mould and the bottom watertight due to the formation of the intervening ice film, and secondly that in which the requisite quantity of water is introduced into the mould.

8. A process according to Claim 5, 6 or 7 wherein the harvesting action is performed in two steps, the first of which consists in lowering the ice block during which precooled water is guided along the wall of the tubular evaporator to fill the hole in the block left thereby and the second of which consists in a final withdrawal of the ice block out of the range of the displaceable mould bottom.

9. Apparatus for carrying out the process according to any of the preceding claims comprising an upright ice mould with a displaceable bottom adapted to be held against the mould, a tubular evaporator extending into and substantially the full length of the mould, a jacket also acting as an evaporator and surrounding at least the lower part of the mould and connected with the tubular evaporator therein, means for circulating a refrigerant through the said evaporator and for subsequently allowing some of the refrigerant to flow from the evaporator into the jacket to gasify and dry through evaporation therein so that water introduced into the

mould is frozen into an ice block, and means for replacing the refrigerant medium with a warm medium for causing the ice block to become detached from the said evaporator and to enable it to be harvested.

10. Apparatus according to Claim 9 wherein a series of upright moulds are arranged in a group and a common jacket is arranged to surround at least the lower part of all the moulds.

11. Apparatus according to Claim 9 wherein the tubular evaporator is provided with an entry pipe and valves to introduce either cold or warm media through said pipe, and a connecting pipe is provided with valve means, open during a freezing period and closed during a detaching period, said connecting pipe further leading to the said jacket which is provided with draining means adapted to displace any cold media when, in a detaching period, warm media enters the jacket.

12. Apparatus according to Claim 9 wherein means are provided for bringing a further warm medium into contact with the exposed walls of the mould to assist in the detaching process, the connecting pipe to the jacket being arranged in metallic contact with the wall of the ice mould.

13. Apparatus according to Claim 11 or 12 comprising a battery of several ice moulds and a common outer chamber through which a warm medium may be passed to envelop the exposed walls of the moulds and assist in the detaching process, the connecting pipes to the jacket being shaped and/or positioned between adjacent ice moulds so that they further deflect the direction of the flow of the warm medium and cause this evenly to envelop the mould walls.

14. Apparatus according to Claim 9 wherein the bottom plate for the ice mould is pivoted in bearings mounted at the lower end of the moulds said bearings being arranged to permit both a parallel movement of the plate when lowered under the influence of the ice-elongation and a flapping movement when tilted by gravitational force, independent return forces being provided to restore the plate into its upper horizontal position in which it lightly abuts the lower edge of the mould.

15. Apparatus according to Claim 14, wherein the bottom plate is subjected to internal biased elastic return forces which temporarily yield to ice-elongation forces and then deform the said plate, substantially parallel to its normal shape.

16. Apparatus according to Claim 13 or 14 wherein means, for example, an electrical contact, is actuated by the elongation of the ice to initiate the detaching process, said means being also actuated by the bottom plate of the mould to initiate the freezing period when this plate regains its upper position.

17. Apparatus according to Claim 9 wherein at the change-over from a freezing period to a detaching period, means are actuated to cause a fluid to flow and envelop the walls of the moulds in order to assist in the detaching.

18. Apparatus according to Claim 12, 13 or 17 using a refrigeration process comprising compressor, condenser, and oil separator which heat up in the process, characterised in that the detaching is assisted by fluids which are warmed up through heat extraction from the bodies of said refrigeration machinery components, before said fluids are made to flow past and envelop the walls of the moulds.

19. Apparatus according to any of Claims 9 to 18, wherein each ice mould is provided with several tubular evaporators arranged to depend into the mould substantially equidistant from each other and the walls of the mould, the evaporators being located symmetrically over the cross-section of the mould.

20. Apparatus according to Claim 19 wherein each ice mould is square and five tubular evaporators are disposed symmetrically along the two diagonals of the square cross-section of each mould.

21. Apparatus according to Claim 9 wherein the bottom of each mould has means to admit water, and also to inject air, into the mould through its bottom plate.

22. Apparatus according to any of Claims 9 to 21 wherein a float valve is placed outside the ice moulds, level with the liquid level to be attained in the moulds, the said valve being connected by means of an admission pipe and hoses with the ice moulds, to determine the quantity of liquid for the moulds.

23. Apparatus according to Claims 21 and 22 comprising a thermostatic member contacting the mould wall and co-operating with the float valve, whereby the supply valve for the liquid to fill up the ice moulds can only be opened at the commencement of the freezing period and until the high level within the moulds is attained.

24. Apparatus according to Claims 21 to 23 wherein such liquid that is, during a freezing and detaching period, retained in the liquid-admission pipe, can begin to drain away and start to fill the moulds immediately upon a harvested ice block tilting the bottom plate and prior to the opening of the supply valve for the liquid when the new freezing period commences.

25. Apparatus according to any of Claims 9 to 24 comprising more than one battery of ice moulds, and a refrigeration circuit including a liquid separator for a refrigerant medium, a common liquid-separator being provided for the evaporated refrigerant in the

suction side of the compressor.

26. Apparatus according to any of Claims 9 to 25 comprising more than one battery of ice moulds, and a refrigeration circuit including a condenser, a common liquid-receptacle being provided to receive, during a detaching period for any one battery, liquefied refrigerant which is then displaced by the evaporators of the battery.

27. Apparatus according to Claim 26 wherein the condenser is used, during a detaching period, to receive liquefied refrigerant which is then displaced by the evaporators of the battery.

28. Apparatus according to any of the preceding Claims 9 to 27, comprising a row of ice-mould batteries and a table trolley to collect falling-out ice blocks of any one battery, the stand for the mould batteries and the trolley both being provided with means which co-operate to locate the trolley in alignment with the various mould-batteries.

29. Apparatus according to Claim 28 wherein the top of the table trolley can be located with respect to the moulds of a battery through vertical guides of the battery stand, said guides allowing the trolley to be rolled away only when the table top is fully lowered.

30. Apparatus according to any of the preceding Claims 9 to 29 wherein liquid supply means are provided to admit and guide along the outside of the tubular evaporators within the ice moulds small amounts of liquid to fill the holes left by the said tubes in the harvested ice blocks.

31. Apparatus according to Claims 28 and 29, characterised in that the trolley table has a parabolic top curve, and that the locating means bring the vertical leg of said curve in alignment underneath the ice moulds of a battery, so that soon after the ice blocks emerge from the moulds they are deflected to be harvested horizontally.

32. An ice block produced according to the process claimed in any of Claims 1 to 8.

33. An ice block produced by the apparatus claimed in any of Claims 9 to 31.

34. An ice block according to Claims 32 or 33 where the meeting areas of the various ice zones, over the cross-section of the block, do not run parallel to the outer surface of the ice block, substantially as illustrated in Figs. 9 to 11.

35. An ice block according to Claims 32, 33 or 34 wherein through a sufficiently low freezing temperature, a quantity of liquid filling up the holes left by the tubular evaporators, combines with the ice zones to complete a harvested ice block.

36. A process for the production and harvesting of an ice block, substantially as described and illustrated in the accompanying drawings.

37. Apparatus for the production and harvesting of an ice block substantially as described and illustrated in the accompanying drawings.

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718,240 COMPLETE SPECIFICATION
5 SHEETS

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SHEET 1

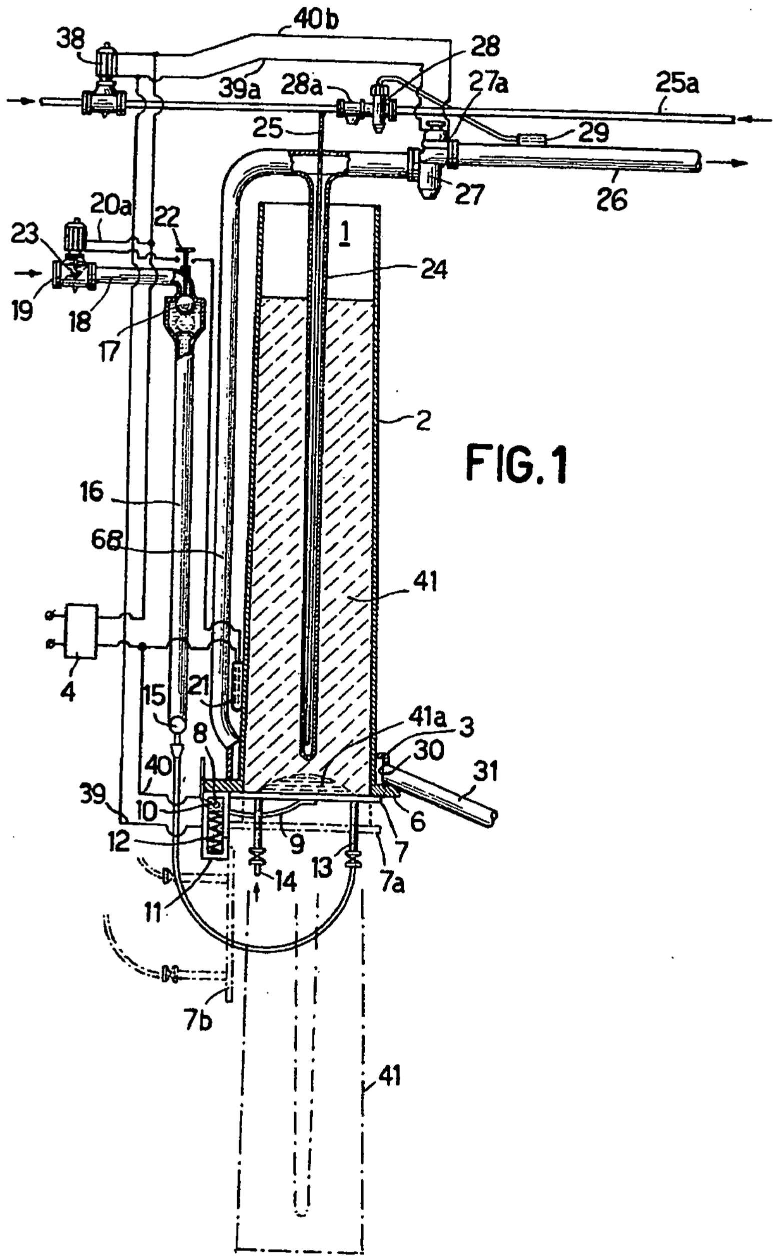


FIG.1

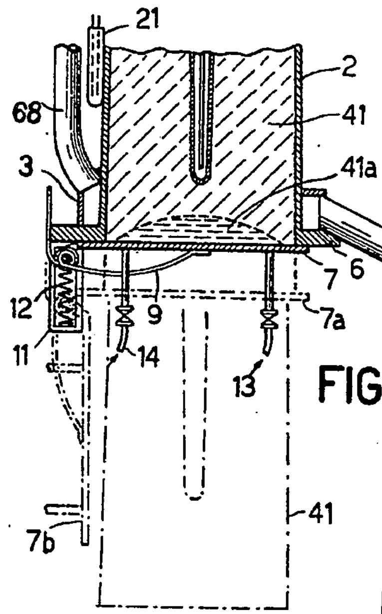


FIG.2

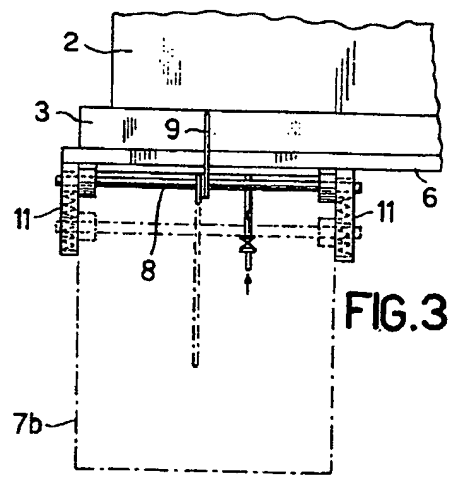
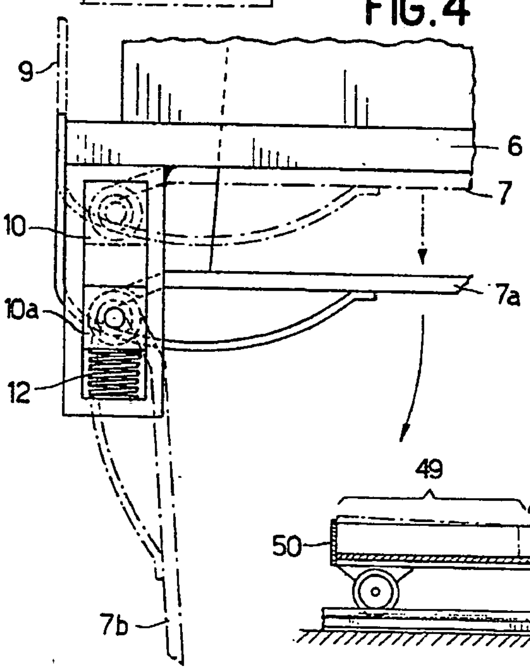


FIG.3

FIG.4



66

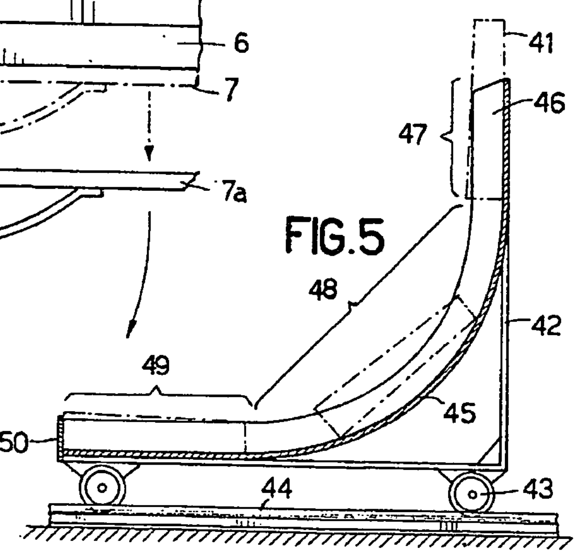


FIG.5

718,240 COMPLETE SPECIFICATION
5 SHEETS
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SHEETS 2 & 3

IG.3

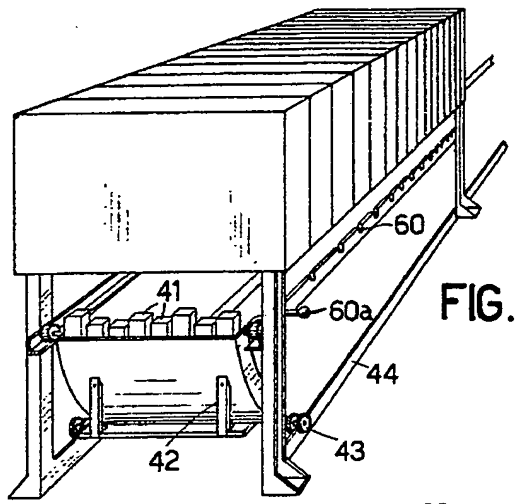

FIG.6

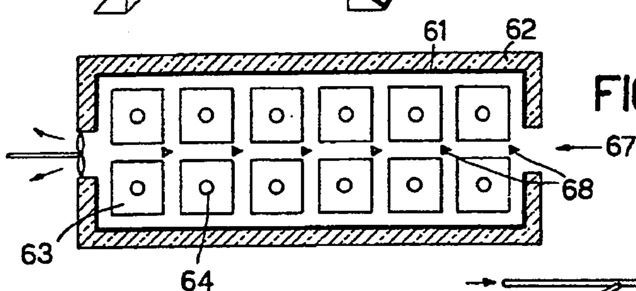

FIG.7

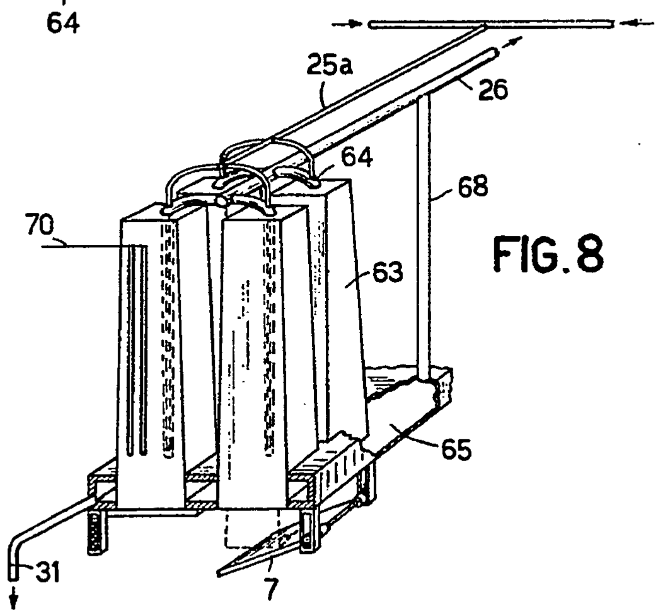

FIG.8

718,240 COMPLETE SPECIFICATION
5 SHEETS
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SHEETS 2 & 3

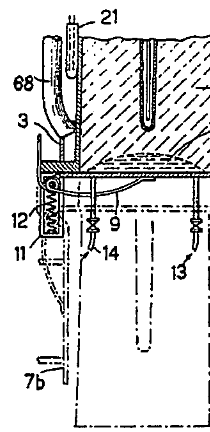


FIG.2

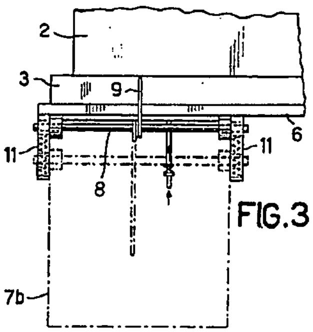


FIG.3

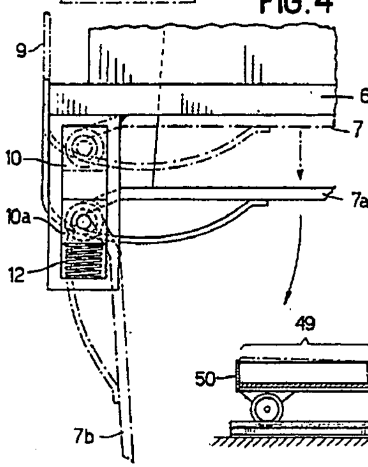


FIG.4

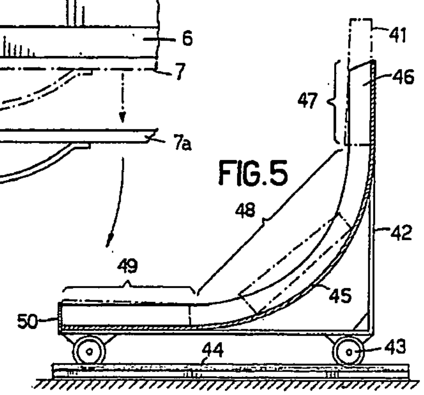


FIG.5

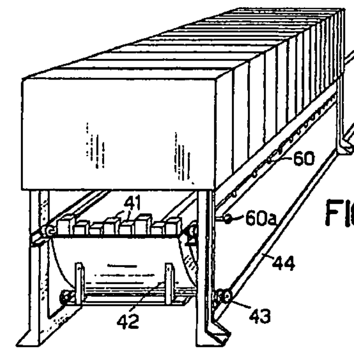


FIG.6

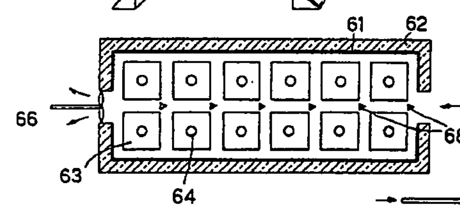


FIG.7

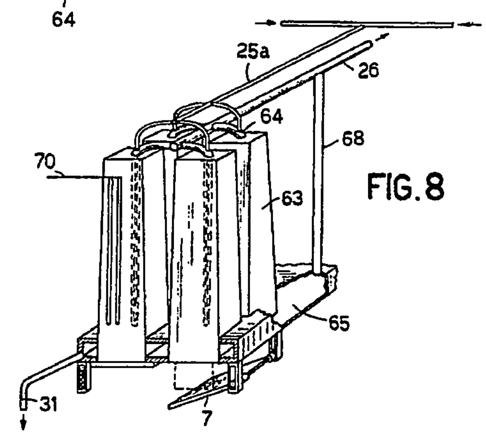


FIG.8

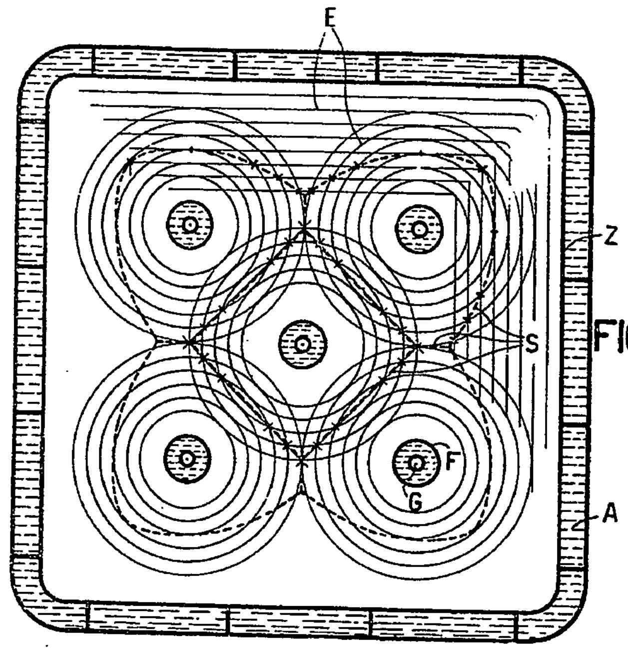


FIG.9

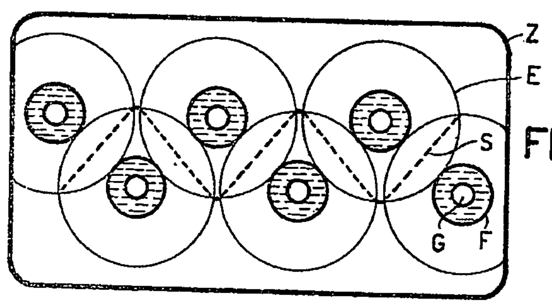


FIG.10

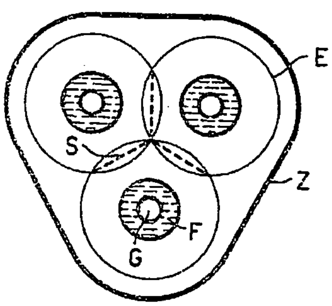
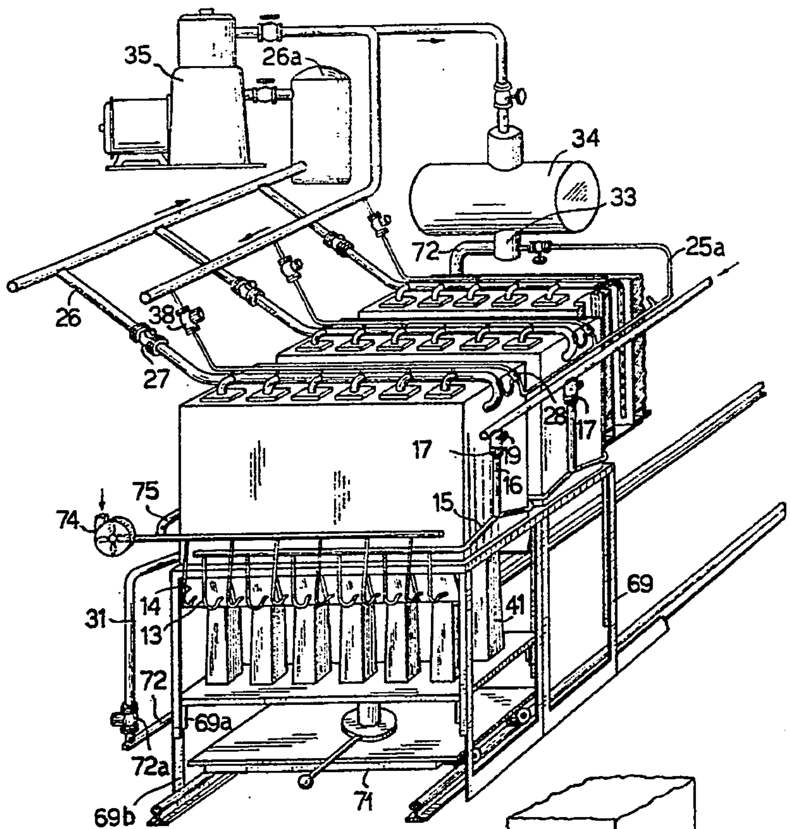


FIG.11

718,240 COMPLETE SPECIFICATION
5 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEETS 4 & 5

FIG. 12



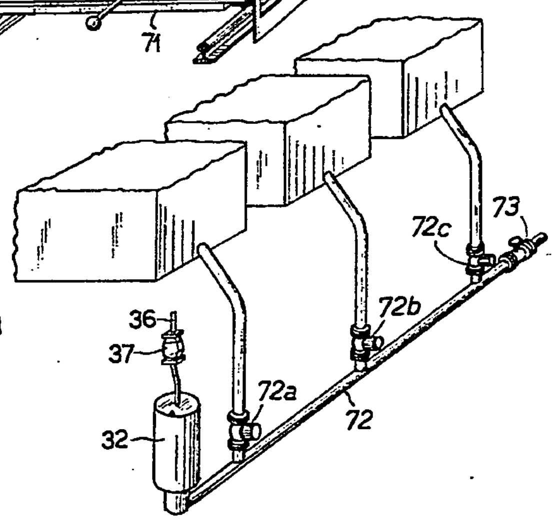


FIG. 12a

718,240 COMPLETE SPECIFICATION
5 SHEETS
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SHEETS 4 & 5

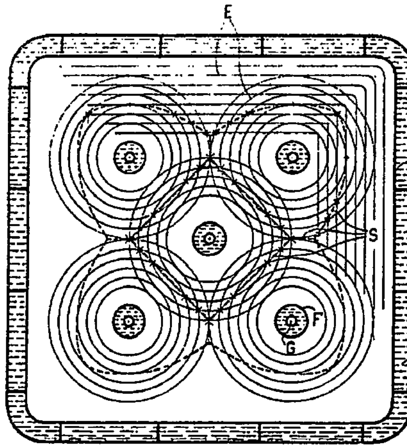


FIG.9

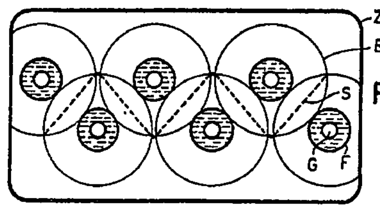


FIG.10

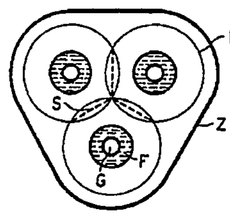
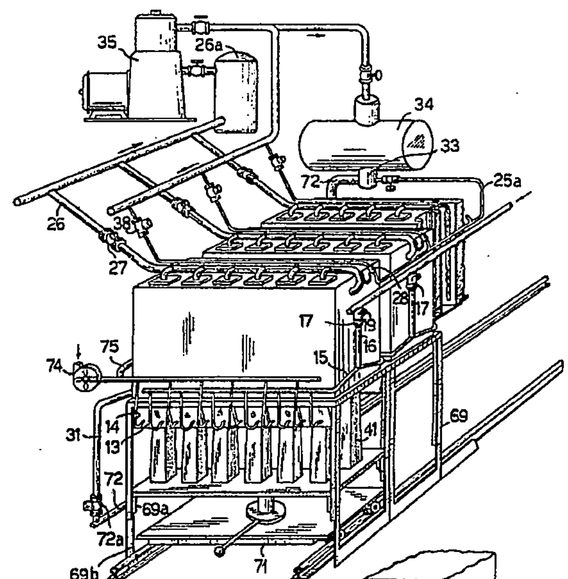


FIG.11

FIG.12



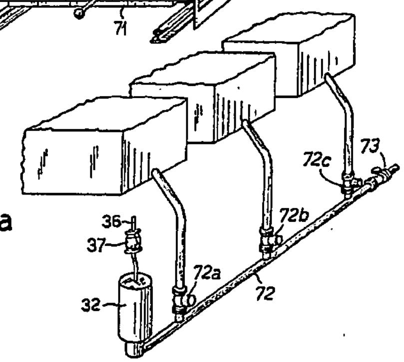


FIG.12a